REMARKS

Claims 1-69 are pending in the application. Claims 15, 17, 30, 43, 48, 52, and 61 have been amended herein. Claim 16 has been canceled without prejudice. New claims 70-87 have been added. No claims have been allowed.

Objections to the Claims

Claim 44 was objected to for being identical to claim 43. Claim 43 has been amended to replace the term "first operating mode" with the originally intended term "second operating mode". Applicants submit that claims 43 and 44 are each now unique.

Regarding claim 61, the Examiner is correct in assuming that "the method of claim 61" should be amended to read "the method of claim 58". Applicants thank the Examiner for pointing out the informality. Applicant have amended claim 61 accordingly.

Applicants respectfully submit that the objections to the claims have been overcome, and request the withdrawal of the objections.

Claim Rejections under 35 U.S.C. § 102 (e)

Claims 1-4, 8-11, 13, and 58-69 were rejected under 35 U.S.C. § 102 (e) as being anticipated by Bechtolsheim et al., U.S. Patent No. 6,377,577. Applicants respectfully submit that the claims are not anticipated by Bechtolsheim.

Bechtolsheim teaches hardware processing of access control lists (ACLs), including use of a conventional CAM device. (column 2, lines 51-58). Bechtolsheim describes the exact matching function of the conventional CAM device, for example, in the Abstract: "the CAM includes an ordered sequence of entries, each of which has an array of ternary elements for matching "0", "1", or any value, and which generates a match signal".

Bechtolsheim seeks to alleviate the drawbacks of searching for ACLs that have been proven to be inconvenient by adding preprocessing circuits. The specification states: "For example, comparisons of the port number against known special cases, such as 'greater than 1023' and 'within the range 6000 to 6500', can be treated by circuitry for performing range comparisons or by reference to one or more auxiliary CAMs". (column 2, lines 59-67). Applicants respectfully submit that Bechtolsheim specifically teaches using conventional, ternary CAM devices in a conventional way to perform comparisons. The problems

associated with comparing certain special cases, such as finding matches within a range, are approached by Bechtolsheim with additional circuitry external to the conventional CAM, and/or by additional conventional CAMs.

The Bechtolsheim disclosure consistently describes an approach using only conventional ternary CAMs, which are notoriously known to store a mask bit and a data bit in each cell. For example, the passages cited in the office action further describe the use of conventional, ternary CAM devices in combination with additional circuitry for performing range comparisons. With reference to column 4, lines 34-47, a CAM has a sequence of access control specifiers, each including a label match mask and a label match pattern. A conventional ternary CAM compare is performed for each mask/pattern combination.

With reference to column 5, line 57-column 6, line 9, an optimization is described for comparing a source port number and a destination port number with common known ranges and providing a set of comparison bits indicating whether or not the compared numbers are within each specified range. The disclosed optimization includes a comparison circuit includes a finite state machine (external to the CAM device) for storing lower and upper bounds for each specified range.

Applicants respectfully assert that Bechtolsheim thus specifically teaches away from storing an upper value and a lower value in a CAM device. Specifically, Bechtolsheim teaches storing a pattern value and a mask value in a CAM device, as is well known, and performing an exact match operation. Further, Bechtolsheim teaches storing an upper value and a lower value in a finite state machine rather than in a CAM device.

The claimed invention, in contrast to Bechtolsheim, includes a CAM device as in claim 1:

> A content addressable memory (CAM) device comprising:
> a first plurality of storage circuits to store an upper value;
> a second plurality of storage circuits to store a lower value; and
> a plurality of compare circuits to determine if a first comparand value is within a range of values defined by the upper value and the lower value.

Applicants respectfully submit that Bechtolsheim lacks any teaching or suggestion regarding storing an upper value and a lower value in a CAM device. Bechtolsheim further

lacks any teaching or suggestion of a plurality of compare circuits in a CAM device, as claimed, to determine if a first comparand value is within a range defined by the upper value and the lower value. Rather, Bechtolsheim merely teaches the compare circuits in the CAM perform a conventional ternary CAM comparison, which does not determine if a comparand value is within a range defined by the upper value and the lower value. For at least these reasons, Applicants respectfully submit that claim 1 is not anticipated by Bechtolsheim. Claims 2-4, 8-11, and 13 depend from claim 1 and include further limitations thereon. Therefore, Applicants respectfully submit these claims are also allowable over Bechtolsheim for the foregoing reasons.

Applicants respectfully submit that independent claim 58 and its dependent claims 59-64 are not anticipated by Bechtolsheim. Claim 58 recites a method of operation within a CAM device comprising comparing a comparand value with a first boundary value stored in one of a plurality of CAM cells within the CAM device. Claim 58 further recites asserting a first result signal if the comparand value is greater than the first boundary value. Bechtolsheim fails to teach or disclose at least asserting a first result signal if the comparand value is greater than the first boundary value as claimed. Therefore, Applicants submit that claim 58 and its dependent claims are not anticipated by Bechtolsheim.

Applicants respectfully submit that independent claim 65 and its dependent claims 66-69 are not anticipated by Bechtolsheim. Claim 65 recites a content addressable memory (CAM) device comprising means for comparing a comparand value with a first boundary value stored in one of a plurality of CAM cells within the CAM device means for asserting a first result signal if the comparand value is greater than the first boundary value. Bechtolsheim fails to teach or disclose at least asserting a first result signal if the comparand value is greater than the first boundary value as claimed. Therefore, Applicants submit that claim 65 and its dependent claims are not anticipated by Bechtolsheim.

Claim 70 recites a CAM device including at least one range compare cell configured to store a bit of a range limit, wherein the at least one range compare cell is further configured to output a result signal that indicates at least whether the stored range limit bit is greater than or less than a corresponding bit of a comparand. Claim 70 further recites at least one CAM cell configured to store a data bit, wherein the at least one CAM cell is further configured to

output a match signal that indicates whether the stored data bit matches a corresponding bit of a comparand, wherein at least one range compare cell and at least one CAM cell are coupled to a common match line.

Bechtolsheim completely fails to teach or suggest a range compare cell in a CAM device that is configured to output a result signal that indicates at least whether the stored range limit bit is greater than or less than a corresponding bit of a comparand. Rather, Bechtolsheim only discloses a conventional ternary CAM cell that indicates a match between a stored, masked bit and a comparand bit. For this reason alone, claim 70 is not anticipated by Bechtolsheim. In addition, however, Bechtolsheim does not teach or suggest a range compare cell and a CAM cell coupled to a common match line. Therefore, Applicants respectfully submit that claim 70 and its dependent claims 71-77 are not anticipated by Bechtolsheim.

Claim 78 recited a method for performing a range compare operation in a CAM device. Bechtolsheim does not disclose performing a range compare operation in a CAM device. Rather, Bechtolsheim discloses performing a range compare operation with the use of a conventional ternary CAM device in addition to other circuitry. For this reason alone, claim 78 is not anticipated by Bechtolsheim. In addition, however, Bechtolsheim fails to disclose at least outputting a result signal for each range compare cell based on the bit comparison, and on a result signal output by a next less significant range compare cell, as claimed. Bechtolsheim further fails to disclose outputting a final result signal from the most significant range compare cell to a match line, wherein the final result signal indicates at least whether the comparand is greater than or less than the range limit. Therefore, Applicants respectfully submit that claim 78 and it dependent claims are not anticipated by Bechtolsheim.

Claim 87 recites a content addressable memory (CAM), comprising a match line and a plurality of CAM cells. The CAM cells include storage circuits to store an upper bound value and a lower bound value and compare circuits coupled to the storage circuits. A most significant compare circuit couples the plurality of CAM cells to the match line. Bechtolsheim does not teach or suggest storage circuits in a CAM to store an upper bound value and a lower bound value. Further, Bechtolsheim teaches away from the invention of claim 87 by teaching a ternary CAM in which, as is well known, every CAM cell is coupled to the match line. For these reasons, Applicants submit that claim 87 is not anticipated by

Bechtolsheim.

Claim Rejections under 35 U.S.C. § 102 (b)

Claims 15, 18, 20-22, 29-32, 45, and 48-54 were rejected under 35 U.S.C. § 102 (b) as being anticipated by Moughanni et al., U.S. Patent No. 6,049,876. Applicants respectfully traverse the rejection.

Moughanni teaches using multiple conventional CAM devices to perform conventional compare operations. Results of the conventional compare operations are combined by additional logic to achieve a final result. Referring to Figure 6 and column 3, line 55-column 7, line 60 (as cited in the Office Action), a page detection logic 50 and a trap region detection logic 52 are disclosed. The detection logics 50 and 52 store high order address bits and low order address bits, respectively. The detection logics 50 and 52 include conventional CAM arrays. Address bus signals from the address bus 16 are compared with contents of the detection logics 50 and 52. The outputs of the detection logics 50 and 52 are combined by logic including AND gates 80, 90, 86, and 96, to generate the trap door signal 18.

Applicants submit that Moughanni does not anticipate the invention of claim 15 for several reasons. For example, Moughanni specifically teaches away from storing a boundary value in a CAM cell, as claimed. Rather, Moughanni teaches storing either high order address bits or low order address bits. Further Moughanni teaches outputting results of conventional CAM comparisons, i.e., an indication of whether there is an exact match, to a logic circuit that generates a final comparison result. The invention of claim 15, on the other hand, recites a CAM cell that includes a first compare circuit to compare a comparand value to a the first boundary value, the first compare circuit including circuitry to output a first result signal in a first state if the comparand value is greater than the first boundary value and in a second state if the comparand value is less than the first boundary value.

The CAM cell of claim 15 further includes an input to receive a second result signal from another CAM cell, wherein the circuitry to output the first result signal in the first state is adapted to output the first result signal in the first state if the comparand value is equal to the first boundary value and the second result signal is in the first state. Moughanni

completely lacks any suggestion or teaching regarding a second result signal as claimed, or a first result signal as claimed.

For at least these reasons, Applicants submit that claim 15 is not anticipated by Moughanni. Claims 18 and 20-22 are dependent from claim 15 and include further limitations thereon. Therefore, Applicants assert that claims 18 and 20-22 are also allowable over Moughanni.

Claim 29 recites a CAM device including a compare circuit configured to compare a comparand value to the first value. The compare circuit is further configured to assert a beyond-boundary signal if a level select signal is in a first state and if the comparand value is greater than the first value. The compare circuit is further configured to assert the beyond-boundary signal if the level select signal is in a second state and if the comparand value is less than the first value. Applicants respectfully submit that Moughanni fails to disclose a CAM device that asserts a signal if a level signal is in a particular state and if the comparand value is less than or greater than a stored value. As previously discussed with reference to the Moughanni disclosure, the detection logics 50 and 52 include conventional CAM devices that perform exact-match type comparisons. Therefore, Moughanni does not teach or suggest a CAM device that performs a greater-than or a less-than comparison. For these reasons, Applicants respectfully submit that claim 29 is not anticipated by Moughanni. Claims 30-32 depend from claim 29 and include further limitations thereon. Applicants therefore submit that claims 30-32 are also allowable over Moughanni.

Claim 45 recites a system including a CAM device that is responsive to an instruction to store a first boundary value in a first plurality of CAM cells, the first plurality of CAM cells each being adapted to compare the a bit of a first boundary value with a bit of a first comparand value in a compare operation and to output a first result signal indicative of whether the bit of the first comparand value is greater than the bit of the first boundary value. Moughanni completely lacks any disclosure or teaching regarding a CAM cell that outputs a result of a compare operation that indicates whether a bit of a comparand value is greater than a boundary value. Therefore, Applicants respectfully submit that claim 45 is not anticipated by Moughanni. Claims 48-54 depend from claim 45 and include further limitations thereon. Applicants therefore submit that claims 48-54 are also allowable over Moughanni.

Applicants further submit that claims 70-87 are patentable over Moughanni. Claim 70 recites a CAM device including at least one range compare cell configured to store a bit of a range limit, wherein the at least one range compare cell is further configured to output a result signal that indicates at least whether the stored range limit bit is greater than or less than a corresponding bit of a comparand. Claim 70 further recites at least one CAM cell configured to store a data bit, wherein the at least one CAM cell is further configured to output a match signal that indicates whether the stored data bit matches a corresponding bit of a comparand, wherein at least one range compare cell and at least one CAM cell are coupled to a common match line.

Moughanni completely fails to teach or suggest a range compare cell in a CAM device that is configured to output a result signal that indicates at least whether the stored range limit bit is greater than or less than a corresponding bit of a comparand. Rather, Moughanni only discloses a conventional ternary CAM cell that indicates a match between a stored, masked bit and a comparand bit. For this reason alone, claim 70 is not anticipated by Moughanni. In addition, however, Moughanni does not teach or suggest a range compare cell and a CAM cell coupled to a common match line. Therefore, Applicants respectfully submit that claim 70 and its dependent claims 71-77 are not anticipated by Moughanni.

Claim 78 recited a method for performing a range compare operation in a CAM device. Moughanni does not disclose performing a range compare operation in a CAM device. Rather, Moughanni discloses performing a range compare operation with the use of a conventional ternary CAM device. For this reason alone, claim 78 is not anticipated by Moughanni. In addition, however, Moughanni fails to disclose at least outputting a result signal for each range compare cell based on the bit comparison, and on a result signal output by a next less significant range compare cell, as claimed. Moughanni further fails to disclose outputting a final result signal from the most significant range compare cell to a match line, wherein the final result signal indicates at least whether the comparand is greater than or less than the range limit. Therefore, Applicants respectfully submit that claim 78 and its dependent claims are not anticipated by Moughanni.

Claim 87 recites a content addressable memory (CAM), comprising a match line and a plurality of CAM cells. The CAM cells include storage circuits to store an upper bound value

and a lower bound value and compare circuits coupled to the storage circuits. A most significant compare circuit couples the plurality of CAM cells to the match line. Moughanni does not teach or suggest storage circuits in a CAM to store an upper bound value and a lower bound value. Further, Moughanni teaches away from the invention of claim 87 by teaching a CAM in which, as is well known, every CAM cell is coupled to the match line. For these reasons, Applicants submit that claim 87 is not anticipated by Moughanni .

Claim Rejections under 35 U.S.C. § 103 (a)

Claims 5-7, 12, and 14 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Bechtolsheim.

Claims 16-17, and 19 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Moughanni.

Claims 23-28, 35-39, and 40-43 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Bechtolsheim in view of Voelkel, U.S. Patent No 6,108,227.

Claims 33-34, 47-47, and 55-57 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Moughanni in view of Voelkel.

Regarding claims 5-7, 12, and 14, Applicants submit that the claims would not have been obvious in view of Bechtolsheim. As previously stated, Bechtolsheim merely teaches the compare circuits in the CAM perform a conventional ternary CAM comparison, which does not determine if a comparand value is within a range defined by the upper value and the lower value. Therefore, Bechtolsheim does not suggest a CAM device that outputs a result signal, as claimed, that indicates at least one of, the comparand is less than or greater than the upper value, and the comparand is less than or greater than the lower value. Because Bechtolsheim specifically teaches using a conventional ternary CAM that performs a masked exact-match type comparison, Applicants submit that the CAM device of the claimed invention that outputs a greater-than or less-than result signal would not have been obvious to one of ordinary skill in the art.

For at least the foregoing reasons, Applicants submit that Bechtolsheim completely lacks any teaching or suggestion regarding the claimed CAM device. Therefore, one of ordinary skill would not be motivated to modify Bechtolsheim to achieve the invention of claims 5-7, 12, and 14.

Regarding claims 16-17, and 19, Applicants respectfully submit claim 16 has been canceled without prejudice, and that the remaining claims would not have been obvious in view of Moughanni. Moughanni simply does not provide any disclosure regarding the operation of the CAM cells in the detection circuits 50 and 52 other than to name them as conventional CAM cells. As such, the Moughanni CAM cells do not provide any teaching regarding outputting the first result signal in a first state if the comparand value is greater than the first boundary value, and outputting the first result signal in a second state if the comparand value is less than the first boundary value. For this reason, at least, Applicants submit that claim 17 and 19 would not have been obvious in view of Moughanni.

Claims 23-28, 35-39, and 40-43 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Bechtolsheim in view of Voelkel, U.S. Patent No 6,108,227. Claims 33-34, 47-47, and 55-57 were rejected under 35 U.S.C. § 103 (a) as being unpatentable over Moughanni in view of Voelkel.

Voelkel is cited for a mode select signal. Voelkel discloses a CAM having conventional binary and conventional ternary modes of operation. The mode select signal of Voelkel switches between binary and ternary modes in a conventional, exact-match type CAM. In the binary mode, a comparand is compared to a stored value to determine whether there is an exact match or not. In the ternary mode, a comparand is compared with the combination of a stored value and a stored mask value to determine whether there is an exact match or not. Neither the combination of Voelkel and Bechtolsheim, nor the combination of Voelkel and Moughanni, yield, or suggest, a CAM device as claimed, including a first result signal indicating whether the comparand value is greater than the first value when the mode signal is in a first state, and the first result signal indicating whether the comparand is equal to the first value when the mode signal is in a second state. Rather, the combined disclosures of Voelkel, Bechtolsheim and Moughanni are specifically limited to binary and ternary CAM devices, which, as is well known in the art, only yield a result indicating whether a stored, masked or unmasked, values exactly matches a comparand. Applicants submit that the addition of Voelkel does not supply the deficiencies of the cited art already described.

Therefore, Applicants respectfully submit that claims 23-28, 35-39, and 40-43 would not have been obvious in view of Bechtolsheim and Voelkel. Applicants further respectfully

submit that claims 33-34, 47-47, and 55-57 would not have been obvious in view of Moughanni and Voelkel.

Applicants respectfully submit that claims 70-87 are allowable over the cited art, including the proposed combinations of Bechtolsheim with Voelkel and Moughanni with Voelkel. Voelkel is cited for the mode select signal which selects between a binary conventional CAM mode and a ternary conventional CAM mode. The combination of a mode select signal with the conventional CAM devices of Bechtolsheim and/or Voelkel does not yield the invention of the claims. Specifically, the combinations do not yield, teach, or suggest the invention of claims 70-77, including a CAM device with at least one range compare cell configured to store a bit of a range limit, wherein the at least one range compare cell is further configured to output a result signal that indicates at least whether the stored range limit bit is greater than or less than a corresponding bit of a comparand.

The proposed combinations also fail to yield, teach, or suggest the invention of claims 78-87, including a method for performing a range compare operation in a CAM device. Bechtolsheim, Moughanni, and/or Voelkel do not disclose performing a range compare operation in a CAM device. Rather, each reference discloses a conventional CAM array with additional, external circuitry to receive, and further process, the conventional CAM output signals. Therefore, Applicants respectfully submit that claims 78-87 would not have been obvious in view of the proposed combinations.

CONCLUSION

In view of the foregoing amendments and remarks, Applicants respectfully submit that all pending claims are allowable over the prior art, including the prior art made of record and not relied upon. The examiner is respectfully invited to call the undersigned if there are any issues that remain to be resolved prior to allowance of the claims.

AUTHORIZATION TO CHARGE DEPOSIT ACCOUNT

Please charge deposit account 501914 for any fees due in connection with this Office Action response.

Respectfully submitted,

Date: 12-17-03

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